Note: Methodology, explanation of analysis and biological background on Catfish Lake studies are contained within the Eagle River Chain-wide Management Plan document.

8.2 Catfish Lake

An Introduction to Catfish Lake

Catfish Lake, Vilas County, is a shallow, lowland drainage lake with a maximum depth of 30 feet, a mean depth of 12 feet, and a surface area of approximately 977 acres. The lake is fed via the Eagle River from upstream Cranberry Lake and drains into downstream Voyageur Lake, and has a surficial watershed that encompasses approximately 99,991 acres. In a study conducted by Onterra in 2012, 39 native aquatic plant species were located in the lake, of which slender naiad (*Najas flexilis*) was the most common. Two non-native plants, Eurasian water-milfoil and purple loosestrife were observed growing in or along the shorelines of Catfish Lake in 2012.

Field Survey Notes

Catfish Lake contains a relatively small littoral zone with the majority of the lake being too deep to support aquatic plant growth. However, the lake's aquatic plant community was found to be species-rich and contains a number of high-quality native species including Vasey's pondweed, a species listed as special concern in Wisconsin.

Photo 8.2 Catfish Lake, Vilas County

Lake at a Glance* – Island Lake

Morphology	
Acreage	977
Maximum Depth (ft)	30
Mean Depth (ft)	12
Volume (acre-feet)	11,724
Shoreline Complexity	6.8
Vegetation	
Curly-leaf Survey Date	July 11, 2013
Comprehensive Survey Date	August 1, 2013
Number of Native Species	39
Threatened/Special Concern Species	Vasey's pondweed (*Potamogeton vaseyi*)
Exotic Plant Species	Eurasian water-milfoil; Purple loosestrife
Simpson's Diversity	0.90
Average Conservatism	6.6
Water Quality	
Wisconsin Lake Classification	Shallow, Lowland Drainage
Trophic State	Eutrophic
Limiting Nutrient	Phosphorus
Watershed to Lake Area Ratio	101:1

**These parameters/surveys are discussed within the Chain-wide portion of the management plan.*

8.2.1 Catfish Lake Water Quality

Water quality data was collected from Island Lake on six occasions in 2013/2014. Onterra staff sampled the lake for a variety of water quality parameters including total phosphorus, chlorophyll-*a*, Secchi disk clarity, temperature, and dissolved oxygen. Please note that the data in these graphs represent concentrations and depths taken during the growing season (April-October), summer months (June-August) or winter (February-March) as indicated with each dataset. Furthermore, unless otherwise noted the phosphorus and chlorophyll-*a* data represent only surface samples. In addition to sampling efforts completed in 2013/2014, any historical data was researched and are included within this report as available.

Unfortunately, somewhat limited data exists for three water quality parameters of interest – total phosphorus and chlorophyll-*a* concentrations and Secchi disk depths. In 2013, average summer phosphorus concentrations (22.4 µg/L) were less than the median value (33.0 µg/L) for other shallow, lowland drainage lakes in the state (Figure 8.2.1-1). The value is a little more than the median value for all lakes within the Northern Lakes and Forests ecoregion. A weighted value from all available data ranks as *Good* for a shallow, lowland drainage lake.

Total phosphorus surface values from 2013 are compared with bottom-lake samples collected during this same time frame in Figure 8.2.1-2. As displayed in this figure, on several occasions surface and bottom total phosphorus concentrations were similar. However on some occasions, namely during July of 2013, the bottom phosphorus concentrations were much greater than the relatively low surface concentrations. During these periods, anoxic conditions were recorded near the bottom of the lake through measurement of dissolved oxygen (refer to Figure 8.2.1-6 and associated text). This is an indication of hypolimnetic nutrient recycling, or internal nutrient loading, which is a process discussed further in the Eagle River Chain-wide document. While this process may be contributing some phosphorus to Catfish Lake's water column, the impacts of nutrient loading are not apparent in the lake's overall water quality; as previously mentioned, Catfish Lake's surface water total phosphorus values are less than the median value for comparable lakes in Wisconsin.

Summer average chlorophyll-*a* concentrations (17 µg/L) were higher than the median value (9.4 µg/L) for other shallow, lowland drainage lakes (Figure 8.2.1-3). Both of these parameters indicate that the lake has enough nutrients for production of aquatic plants, algae, and other organisms but not so much that a water quality issue is present. During 2013 visits to the lake, Onterra ecologists recorded field notes describing good water conditions.

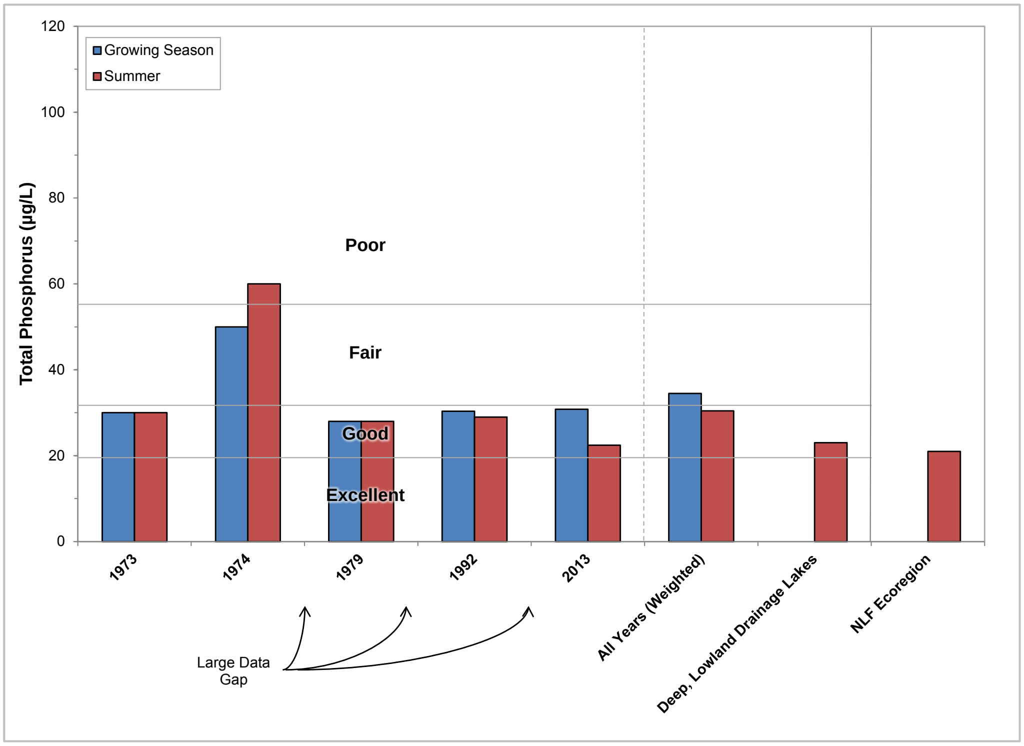

Figure 8.2.1-1. Catfish Lake, statewide deep, lowland drainage lakes, and regional total phosphorus concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

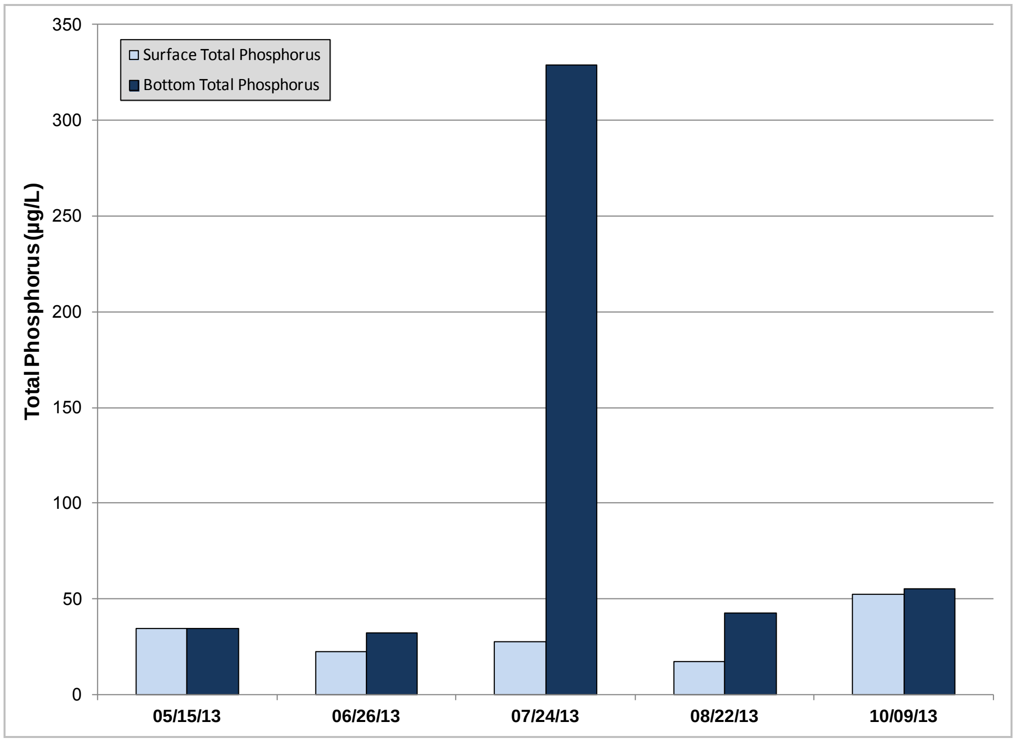

Figure 8.2.1-2. Catfish Lake surface and bottom total phosphorus values, 1973-2013. Anoxia was observed in the hypolimnion of the lake during August sampling visits.

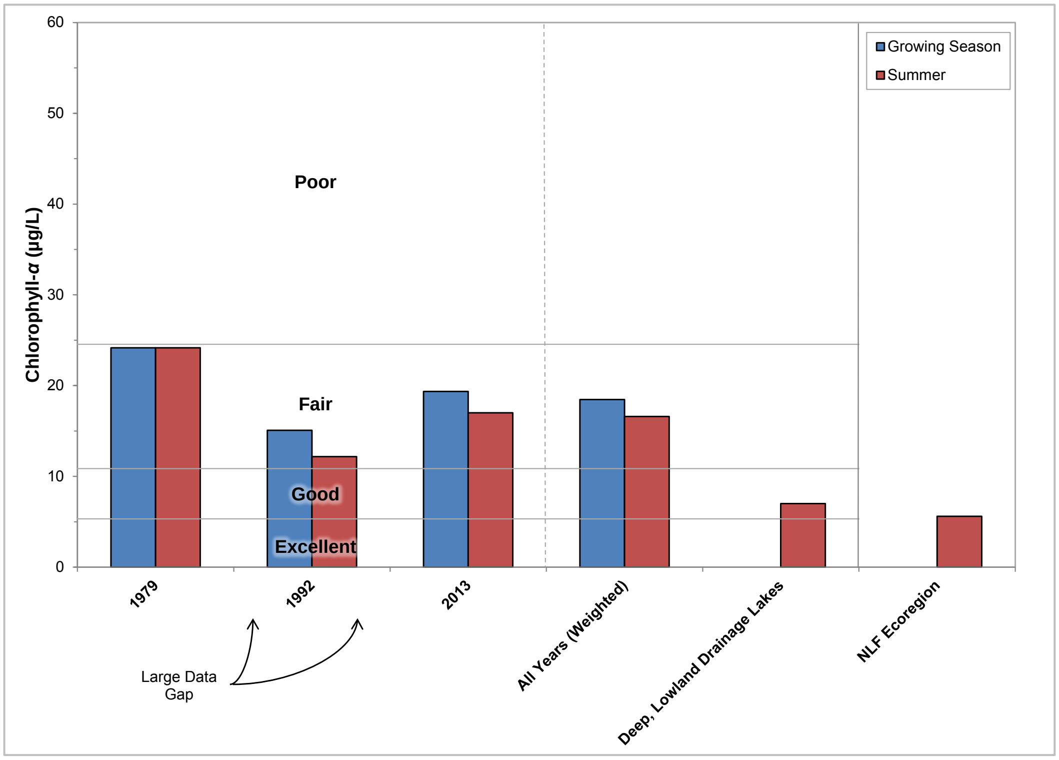

Figure 8.2.1-3. Catfish Lake, statewide deep, lowland drainage lakes, and regional chlorophyll-*a* concentrations. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

From the examination of nearly two decades worth of Secchi disk clarity data, several conclusions can be drawn. First, the clarity of Catfish Lake's water can be described as *Good* to *Excellent* (Figure 8.1.1-4). A weighted average over this timeframe is less than the median value for other shallow, lowland drainage lakes in the state. Secondly, there is no apparent trend in the clarity of the water in Catfish Lake; the data indicate that clarity may differ from one year to the next, but has not gotten "worse" or "better" over this time period. Annual variation is however apparent.

Secchi disk clarity is influenced by many factors, including plankton production and suspended sediments, which themselves vary due to several environmental conditions such as precipitation, sunlight, and nutrient availability. In Catfish Lake as well as the other lakes in the Eagle River Chain of Lakes, a natural staining of the water plays a role in light penetration, and thus water clarity, as well. The waters of Catfish Lake contain naturally occurring organic acids that are washed into the lake from nearby wetlands. The acids are not harmful to humans or aquatic species; they are by-products of decomposing terrestrial and wetland plant species. This natural staining may reduce light penetration into the water column, which reduces visibility and also reduces the growing depth of aquatic vegetation within the lake.

"True color" measures the dissolved organic materials in water. Water samples collected in May and July of 2013 were measured for this parameter, and were found to be 30 Platinum-cobalt units (Pt-co units, or PCU). Lillie and Mason (1983) categorized lakes with 0-40 PCU as having "low" color, 40-100 PCU as "medium" color, and >100 PCU as high color.

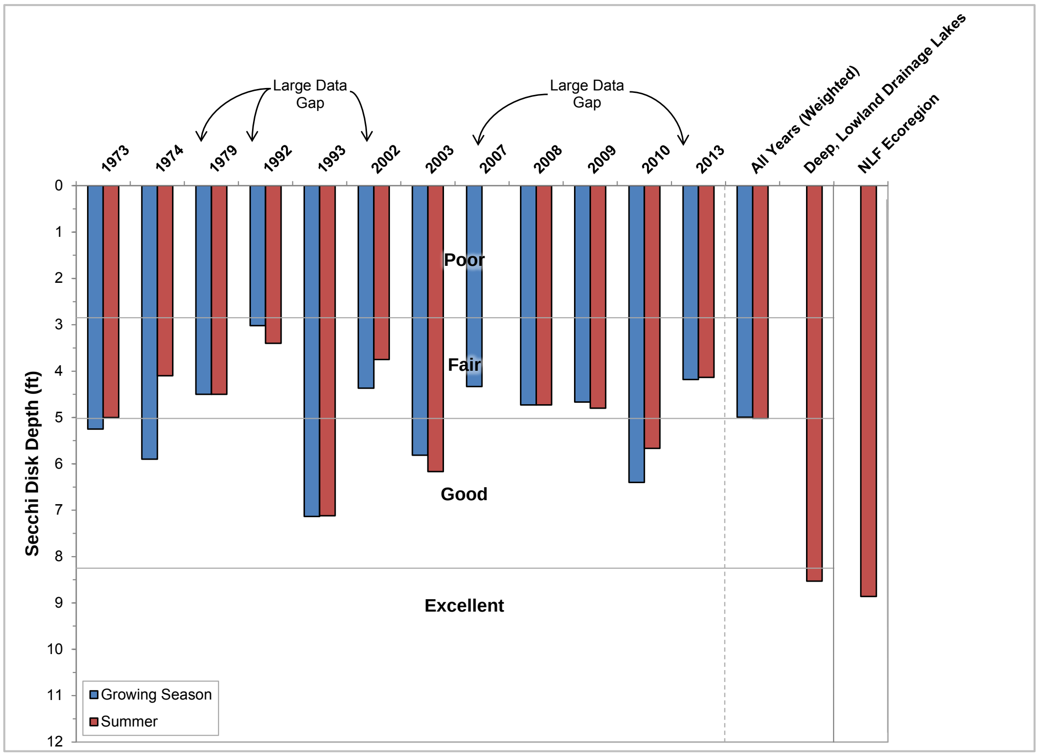

Figure 8.2.1-4. Catfish Lake, statewide deep, lowland drainage lakes, and regional Secchi disk clarity values. Mean values calculated with summer month surface sample data. Water Quality Index values adapted from WDNR PUB WT-913.

Catfish Lake Trophic State

The TSI values calculated with Secchi disk, chlorophyll-*a*, and total phosphorus values range in values spanning from lower mesotrophic to eutrophic (Figure 8.2.1-5). In general, the best values to use in judging a lake's trophic state are the biological parameters; therefore, relying primarily on total phosphorus and chlorophyll-*a* TSI values, it can be concluded that Catfish Lake is in a eutrophic state.

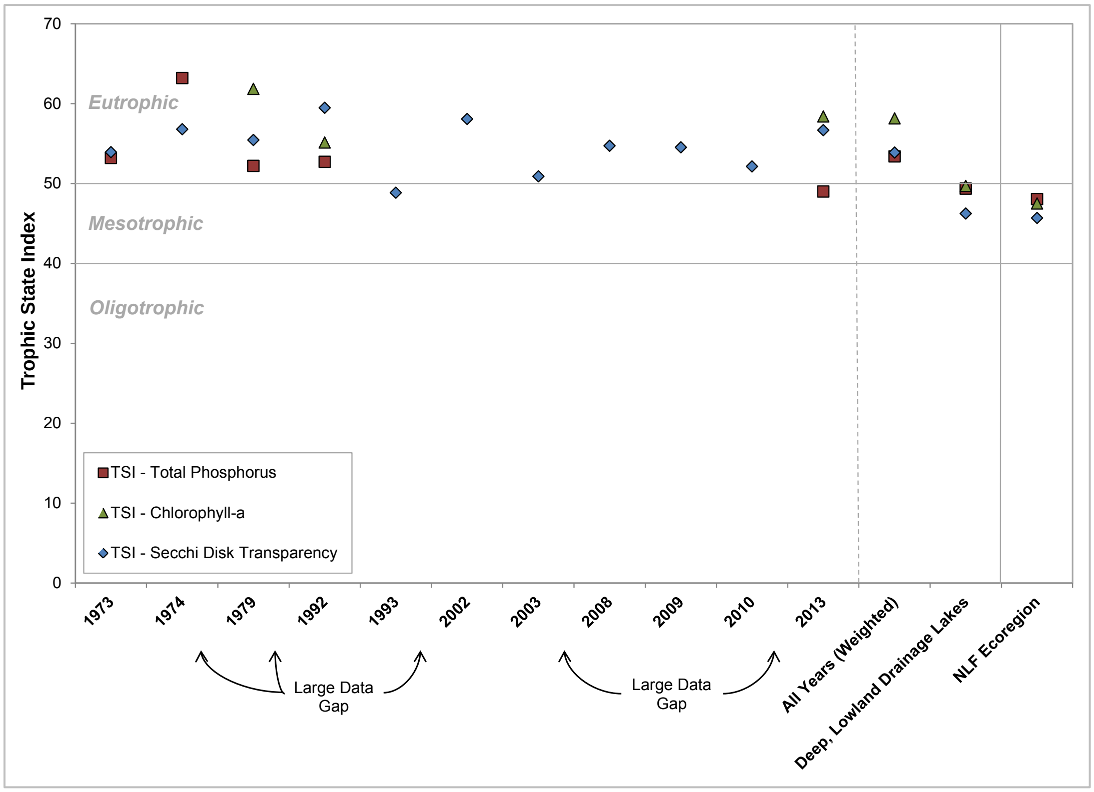

Figure 8.2.1-5. Catfish Lake, statewide deep, lowland drainage lakes, and regional Trophic State Index values. Values calculated with summer month surface sample data using WDNR PUB-WT-193.

Dissolved Oxygen and Temperature in Catfish Lake

Dissolved oxygen and temperature profiles were created during each water quality sampling trip made to Catfish Lake by Onterra staff. Graphs of those data are displayed in Figure 8.2.1-6 for all sampling events.

Catfish Lake mixes thoroughly during the spring and fall, when changing air temperatures and gusty winds help to mix the water column. During the summer months, the bottom of the lake becomes void of oxygen and temperatures remain fairly cool as they were in the spring months. This occurrence is not uncommon in deep Wisconsin lakes, where wind energy is not sufficient during the summer to mix the entire water column – only the upper portion. During this time, bacteria break down organic matter that has collected at the bottom of the lake and in doing so utilize any available oxygen.

The lake mixes completely again in the fall, re-oxygenating the water in the lower part of the water column. During the winter months, the coldest temperatures are found just under the overlying ice, while oxygen gradually diminishes once again towards the bottom of the lake. In February of 2014, oxygen levels remained sufficient throughout most of the water column to support most aquatic life in northern Wisconsin lakes.

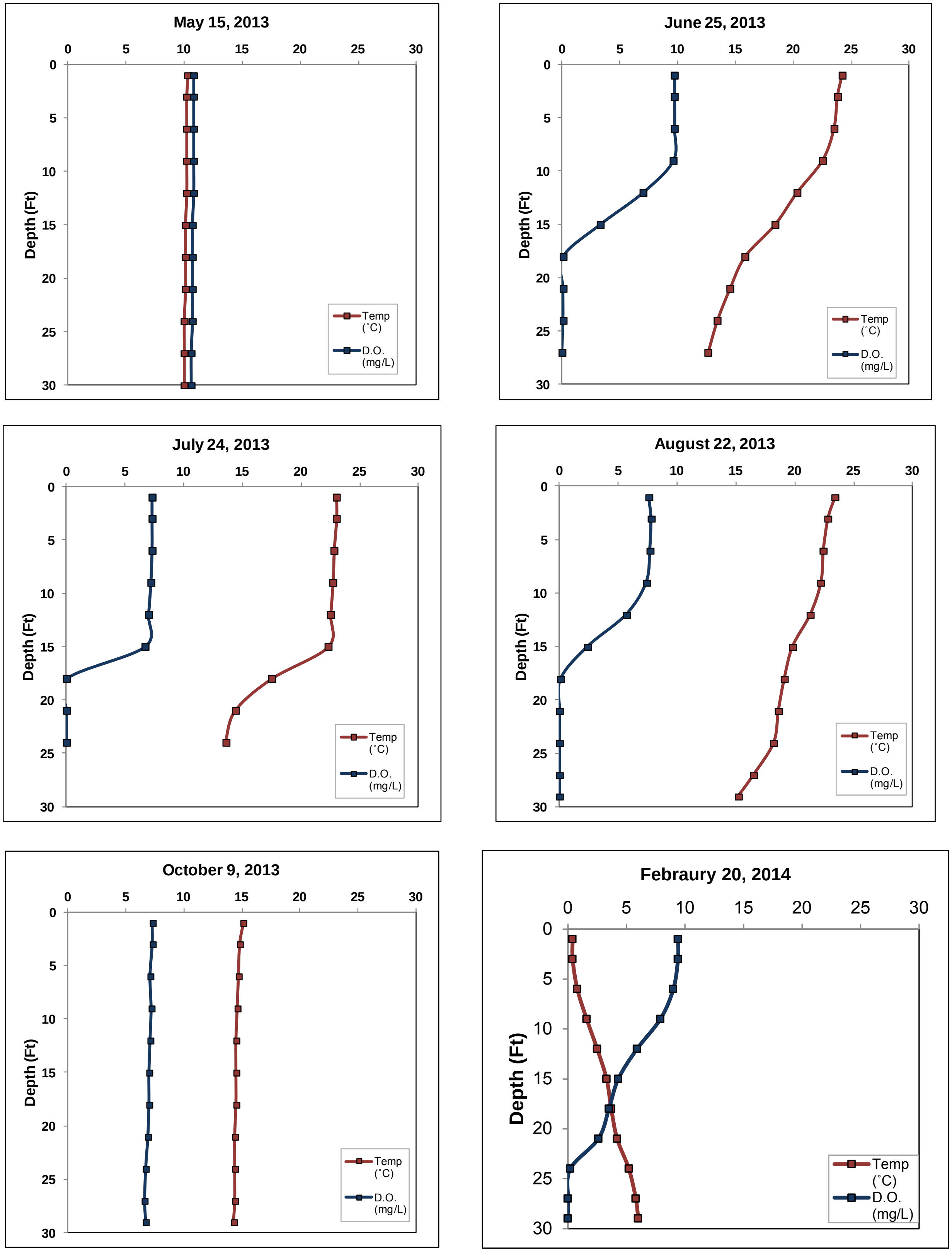

Figure 8.2.1-6. Catfish Lake 2013/2014 dissolved oxygen and temperature profiles.

Additional Water Quality Data Collected at Catfish Lake

The water quality section is centered on lake eutrophication. However, parameters other than water clarity, nutrients, and chlorophyll-*a* were collected as part of the project. These other parameters were collected to increase the understanding of Catfish Lake's water quality and are recommended as a part of the WDNR long-term lake trends monitoring protocol. These parameters include; pH, alkalinity, and calcium.

As the Chain-wide Water Quality Section explains, the pH scale ranges from 0 to 14 and indicates the concentration of hydrogen ions (H^+) within the lake's water and is thus an index of the lake's acidity. Catfish Lake's surface water pH was measured at roughly 7.1 during May and 7.8 during July of 2013. These values are near or slightly above neutral and fall within the normal range for Wisconsin lakes. Fluctuations in pH with respect to seasonality is common; in-lake processes such as photosynthesis by plants act to reduce acidity by carbon dioxide removal while decomposition of organic matter add carbon dioxide to water, thereby increasing acidity.

A lake's pH is primarily determined by the amount of alkalinity that is held within the water. Alkalinity is a lake's capacity to resist fluctuations in pH by neutralizing or buffering against inputs such as acid rain. Lakes with low alkalinity have higher amounts of the bicarbonate compound (HCO_3^-) while lakes with a higher alkalinity have more of the carbonate compound of alkalinity ($CO_3^=$). The carbonate form is better at buffering acidity, so lakes with higher alkalinity are less sensitive to acid rain than those with lower alkalinity. The alkalinity in Catfish Lake was measured at 30 and 32 mg/L as $CaCO_3$ in May and July of 2013. This indicates that the lake has a substantial capacity to resist fluctuations in pH and has a low sensitivity to acid rain.

Samples of calcium were also collected from Catfish Lake during 2013. Calcium is commonly examined because invasive and native mussels use the element for shell building and in reproduction. Invasive mussels typically require higher calcium concentrations than native mussels. The commonly accepted pH range for zebra mussels is 7.0 to 9.0, so Catfish Lake's pH of 7.1 – 7.8 falls within this range. Lakes with calcium concentrations of less than 12 mg/L are considered to have very low susceptibility to zebra mussel establishment. The calcium concentration of Catfish Lake was found to be 7.52 mg/L in June and 8.74 mg/L in August of 2013, which is below the optimal range for zebra mussels. Plankton tows were completed by Onterra staff during the summer of 2013 and these samples were processed by the WDNR for larval zebra mussels. *Results to be included within the next draft.*

True color is a measure of water clarity once suspended material (i.e. algae, sediments) has been removed is called true color. True color measures the amount of light scattered and absorbed by organic materials dissolved within the water. Many lakes in the northern region of Wisconsin have natural dissolved organic materials from decomposing plant material delivered from wetlands within the watershed. These give the water a tea-like color and decrease water clarity. Catfish Lake had an average true color value of 30.0 SU (standard units), indicating the water is most often lightly tea-colored. Lakes with large areas of forests and wetlands within their watersheds tend to have tea-colored or stained water, as these dissolved organic materials within the lake's water originate from decaying vegetation within the watershed.

8.2.2 Catfish Lake Watershed Assessment

Catfish Lake's watershed is approximately 99,991 acres in size. Compared to its surface area of 977 acres, this makes for a large watershed to lake area ratio of 101:1.

Exact land cover calculation and modeling of nutrient input to Catfish Lake will be completed towards the end of this project (in 2016-2017). By this time, the latest satellite imagery (and thus the most accurate land cover delineation) will be available. Additionally, when water quality sampling of the upper reaches of the chain is completed, these results will be input to predictive models and thus make the modeling of nutrient input to the entire chain more accurate.

8.2.3 Catfish Lake Shoreland Condition

Shoreland Development

As mentioned previously in the Chain-wide Shoreland Condition Section, one of the most sensitive areas of the watershed is the immediate shoreland area. This area of land is the last source of protection for a lake against surface water runoff, and is also a critical area for wildlife habitat. In late summer of 2013, Catfish Lake's immediate shoreline was assessed in terms of its development. Catfish Lake has stretches of shoreland that fit all of the five shoreland assessment categories. In all, 2.6 miles of natural/undeveloped and developed-natural shoreline were observed during the survey (Figure 8.1.3-1). This constitutes about 23% of Catfish Lake's shoreline. These shoreland types provide the most benefit to the lake and should be left in their natural state if at all possible. During the survey, 4.7 miles of urbanized and developed–unnatural shoreline (60%) was observed. If restoration of the Catfish Lake shoreline is to occur, primary focus should be placed on these shoreland areas as they currently provide little benefit to, and actually may harm, the lake ecosystem. Catfish Lake – Map 1 displays the location of these shoreline lengths around the entire lake.

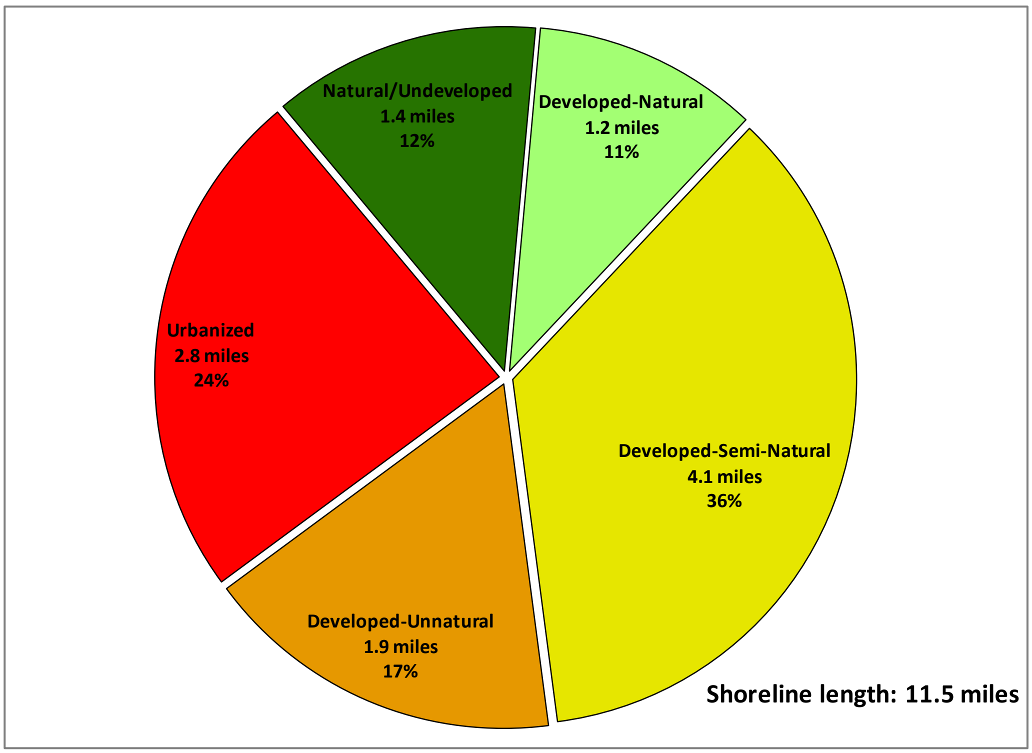

Figure 8.2.3-1. Catfish Lake shoreland categories and total lengths. Based upon a late summer 2013 survey. Locations of these categorized shorelands can be found on Catfish Lake – Map 1.

Coarse Woody Habitat

A survey for coarse woody habitat was conducted in conjunction with the shoreland assessment (development) survey. Coarse woody habitat was identified, and classified in several size categories (2-8 inches diameter, >8 inches diameter and cluster) as well as four branching categories: no branches, minimal branches, moderate branches, and full canopy. As discussed in the Eagle River Chain-wide document, research indicates that fish species prefer some branching as opposed to no branching on coarse woody habitat, and increasing complexity is positively correlated with higher fish species richness, diversity and abundance.

During this survey, 196 total pieces of coarse woody habitat were observed along 11.5 miles of shoreline, which gives Catfish Lake a coarse woody habitat to shoreline mile ratio of 17:1 (Figure 8.1.3-2). Locations of coarse woody habitat are displayed on Catfish Lake – Map 2. To put this into perspective, Wisconsin researchers have found that in completely undeveloped lakes, an average of 345 coarse woody habitat structures may be found per mile (Christensen et al. 1996).

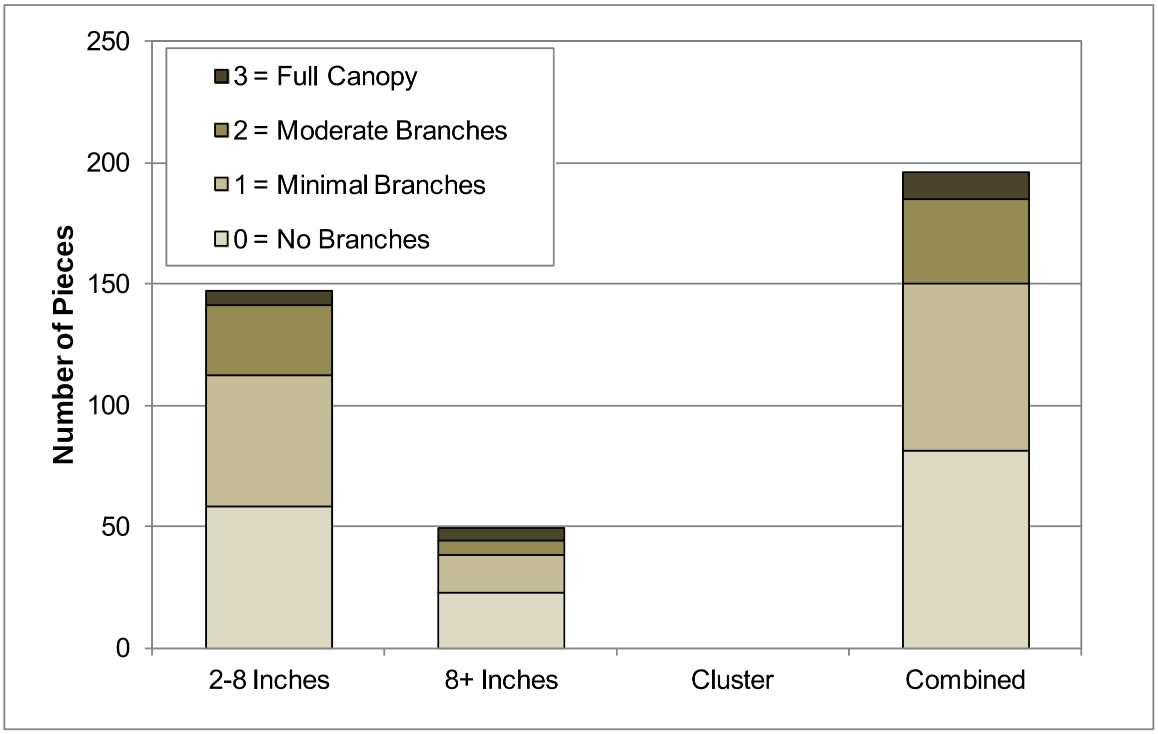

Figure 8.2.3-2. Catfish Lake coarse woody habitat survey results. Based upon a late summer 2013 survey. Locations of Catfish Lake coarse woody habitat can be found on Catfish Lake – Map 2.

8.2.4 Catfish Lake Aquatic Vegetation

An early season aquatic invasive species survey was conducted on Catfish Lake on July 11, 2013. While the intent of this survey is to locate any potential non-native species within the lake, the primary focus is to locate occurrences of curly-leaf pondweed which should be at or near its peak growth at this time. During this meander-based survey of the littoral zone, Onterra ecologists did not locate any occurrences of curly-leaf pondweed.

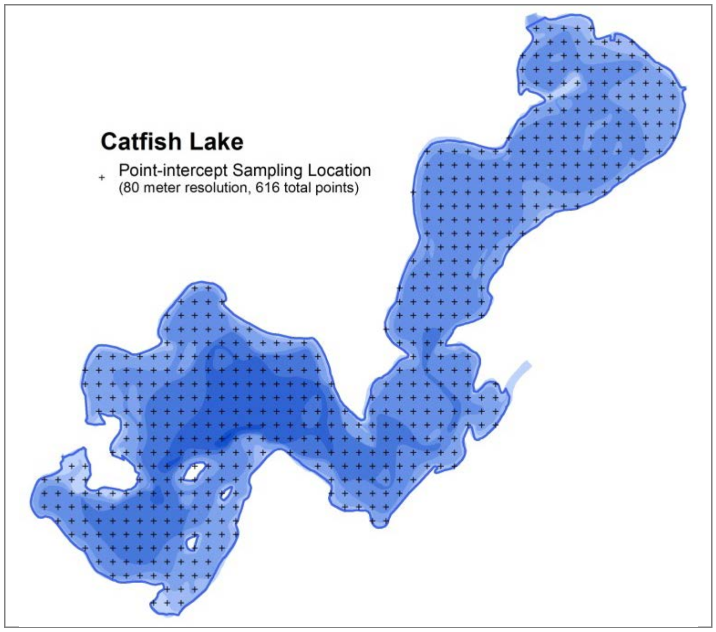

Figure 8.2.4-1. Point-intercept locations on Catfish Lake.

The whole-lake aquatic plant point-intercept survey was conducted on Catfish Lake by Onterra on July 31 and August 1, 2012 (Figure 8.2.4-1), while the aquatic plant community mapping survey was conducted on August 14 and 15, 2013. During these surveys, a total of 30 aquatic plant species were located, only one of which is considered to be a non-native, invasive species: Eurasian water milfoil (Table 4.2-1). One native plant species located, Vasey's pondweed (*Potamogeton vaseyi*), is listed by the Wisconsin Natural Heritage Inventory Program as a species of 'special concern' because it is rare or uncommon in Wisconsin and there is uncertainty regarding its abundance and distribution within the state.

As discussed in the primer section, sediment data were collected at each sampling location within the littoral zone during the point-intercept survey. Approximately 48% of the point-intercept locations within littoral areas contained sand, 46% contained fine, organic sediments (muck), and 6% contained rock. The majority of the shallow, near-shore areas contained sand and/or rock, while the deeper areas of the littoral zone were comprised of muck. Like terrestrial plants, different aquatic plant species are adapted to grow in certain substrate types; some species are only found growing in mucky substrates, others only in sandy areas, and some can be found growing in either. Lakes that have varying substrate types generally support a higher number of plant species because the different habitat types that are available.

During the 2012 point-intercept survey, aquatic plants were found growing to a maximum depth of 14 feet, similar to 15 feet observed in 2006. The water within the Lower Eagle River Chain of Lakes is considered 'stained,' or contains dissolved organic compounds which gives the water a tea-like color. These compounds scatter light and limit the amount that can penetrate vertically into the water column. Thus, the growth of aquatic plants within the chain's lakes is restricted to shallower areas where they can receive enough light to photosynthesize.

Table 8.2.4-1. Aquatic plant species located in Catfish Lake during 2006 and 2012 point-intercept surveys.

Growth Form	Scientifc Name	Common Name	Coefficient of Conservatism (C)	2006 (NEI)	2012/2013 (Onterra)
E	*Carex utriculata*	Common yellow lake sedge	7		I
E	*Equisetum fluviatile*	Water horsetail	7		I
E	*Iris pseudacorus*	Pale-yellow iris	Exotic		I
E	*Lythrum salicaria*	Purple loosestrife	Exotic		I
E	*Pontederia cordata*	Pickerelweed	9		I
E	*Sagittaria rigida*	Stiff arrowhead	8		I
E	*Schoenoplectus acutus*	Hardstem bulrush	5		I
E	*Schoenoplectus tabernaemontani*	Softstem bulrush	4	X	X
E	*Typha* spp.	Cattail spp.	1		I
FL	*Brasenia schreberi*	Watershield	7		I
FL	*Nuphar variegata*	Spatterdock	6	X	X
FL	*Nymphaea odorata*	White water lily	6		X
FL/E	*Sparganium angustifolium*	Narrow-leaf bur-reed	9		X
FL/E	*Sparganium eurycarpum*	Common bur-reed	5		I
FL/E	*Sparganium fluctuans*	Floating-leaf bur-reed	10		I
FL/E	*Sparganium* sp.	Bur-reed sp.	N/A	X	
Submergent	*Bidens beckii*	Water marigold	8	X	I
Submergent	*Ceratophyllum demersum*	Coontail	3	X	X
Submergent	*Chara* spp.	Muskgrasses	7	X	X
Submergent	*Elodea canadensis*	Common waterweed	3	X	X
Submergent	*Heteranthera dubia*	Water stargrass	6		X
Submergent	*Isoetes* spp.	Quillwort species	8	X	X
Submergent	*Lobelia dortmanna*	Water lobelia	10	X	
Submergent	*Myriophyllum sibiricum*	Northern water milfoil	7	X	X
Submergent	*Myriophyllum spicatum*	Eurasian water milfoil	Exotic	X	X
Submergent	*Najas flexilis*	Slender naiad	6	X	X
Submergent	*Nitella* spp.	Stoneworts	7	X	X
Submergent	*Potamogeton amplifolius*	Large-leaf pondweed	7	X	X
Submergent	*Potamogeton epihydrus*	Ribbon-leaf pondweed	8		X
Submergent	*Potamogeton foliosus*	Leafy pondweed	6		X
Submergent	*Potamogeton friesii*	Fries' pondweed	8		X
Submergent	*Potamogeton praelongus*	White-stem pondweed	8		X
Submergent	*Potamogeton pusillus*	Small pondweed	7	X	X
Submergent	*Potamogeton richardsonii*	Clasping-leaf pondweed	5	X	X
Submergent	*Potamogeton robbinsii*	Fern pondweed	8	X	X
Submergent	*Potamogeton spirillus*	Spiral-fruited pondweed	8	X	X
Submergent	*Potamogeton strictifolius*	Stiff pondweed	8		X
Submergent	*Potamogeton vaseyi**	Vasey's pondweed	10	X	X
Submergent	*Potamogeton zosteriformis*	Flat-stem pondweed	6	X	X
Submergent	*Sagitaria* sp. (rosette)	Arrowhead rosette	N/A		X
Submergent	*Vallisneria americana*	Wild celery	6	X	X
S/E	*Eleocharis acicularis*	Needle spikerush	5		X
FF	*Spirodela polyrhiza*	Greater duckweed	5		X

E = Emergent, FL = Floating Leaf; FL/E = Floating Leaf and Emergent; S/E = Submergent and Emergent, FF = Free-floating
X = Located on rake during point-intercept survey; I = Incidental Species
** = Species listed as 'special concern' in Wisconsin*

Of the 407 point-intercept sampling locations that fell at or below the maximum depth of plant growth in 2012, approximately 35% contained aquatic vegetation. This is the same frequency that was recorded during the 2006 survey. Catfish Lake – Map 3 displays the point-intercept locations that contained aquatic vegetation in 2012, and the total rake fullness (TRF) ratings at those locations. Most of the aquatic vegetation in 2012 was located within shallower areas of the lake, mainly near shore throughout the lake. Fifteen percent of the point-intercept locations had a total rake fullness rating of 1, 13% had a total rake fullness rating of 2, and 13% had the highest total rake fullness rating of 3. Total rake fullness ratings were not recorded during the 2006 survey, so a comparison cannot be made.

Table 8.2.4-1 displays the aquatic plant species located in Catfish Lake during the 2006 Northern Environmental, Inc. (NEI) and Onterra 2012 point-intercept surveys. All of the species recorded in 2006, except water lobelia, were recorded in 2012. Water lobelia is a small, inconspicuous species that was only located at one sampling location in 2006; it is not believed to have disappeared from the lake, but rather exists at a low occurrence and was not detected in 2012. An additional 10 native aquatic plant species were located in 2012 that had not been recorded in 2006 (Table 8.2.4-1).

Of the 28 aquatic plant species recorded on the rake during the 2012 point-intercept survey, slender naiad, wild celery, small pondweed, and spiral-fruited pondweed were the four-most frequently encountered (Figure 8.2.4-2). Slender naiad, the most abundant aquatic plant in Catfish Lake in 2012 with a littoral occurrence of nearly 27%, is one of three native naiads that can be found in Wisconsin. Being an annual, it produces numerous seeds on an annual basis and is considered to be one of the most important food sources for a number of migratory waterfowl species (Borman et al. 1997). In addition, slender naiad's small, condensed network of leaves provide excellent habitat for aquatic invertebrates.

Wild celery, or tape grass, was the second-most abundant aquatic plant encountered in 2012 with a littoral occurrence of approximately 19%. This species has bundles of long submersed leaves that are flat and ribbon-like which emerge from a basil rosette and provide excellent structural habitat for aquatic organisms. Spreading rapidly via rhizomes, wild celery is often found growing in large colonies where their extensive root systems stabilize bottom sediments. In mid- to late-summer, the coiled flower stalks of wild celery can be observed at or near the surface, and following pollination, large banana-shaped seed pods can also be seen. These seed pods have been shown to be an important food source for waterfowl (Borman et al. 1997).

Small pondweed was the third-most abundant aquatic plant encountered in Catfish Lake in 2012, with a littoral occurrence of approximately 17%. Small pondweed is one of several narrow-leaved pondweed species that can be found in Wisconsin. In Catfish Lake, it was observed growing in tall, dense stands, which provide excellent structural habitat for aquatic organisms. Unlike two other narrow-leaved pondweed species located in Catfish Lake, spiral-fruited and Vasey's pondweeds, small pondweed does not produce floating-leaves.

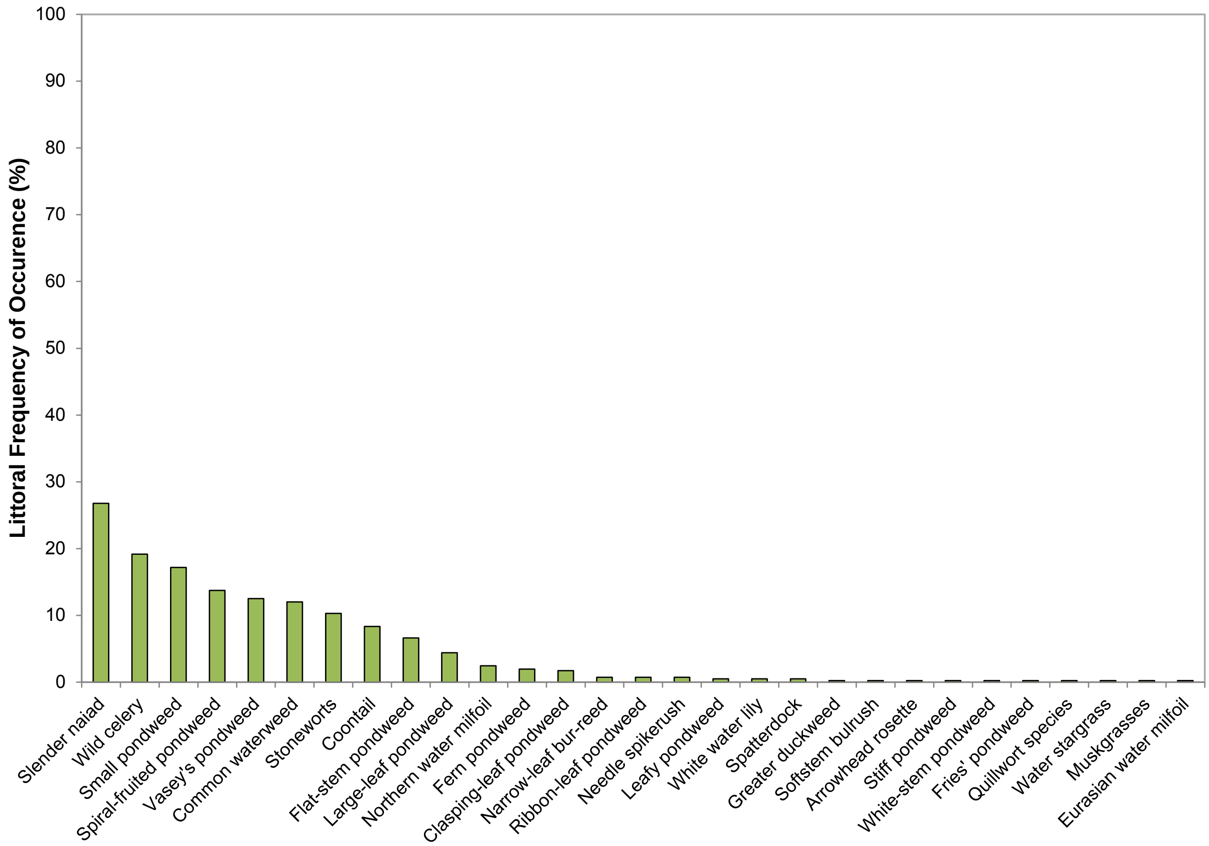

Figure 8.2.4-2. Catfish Lake 2012 aquatic plant littoral frequency of occurrence. Created using data from 2012 aquatic plant point-intercept survey. Non-native species are indicated in red.

Spiral-fruited pondweed was the fourth-most abundant aquatic plant encountered in 2012, with a littoral occurrence of approximately 17%. As its name indicates, produces fruit with a distinct coiled embryo and like small pondweed is one of several narrow-leaved pondweed species that can be found in Wisconsin. In mid-summer, the floating leaves of spiral-fruited pondweed can be observed on the surface in shallow water. The submersed leaves are long and narrow, and are usually curved. Spiral-fruited pondweed is a provider of food and habitat for wildlife.

Vasey's pondweed was the fifth-most frequently encountered aquatic plant species in 2012. As mentioned previously, Vasey's pondweed is listed as a special concern species due to its rarity and uncertainty regarding its abundance in Wisconsin. Like spiral-fruited pondweed, Vasey's pondweed is a narrow-leaf pondweed, but its leaves are much finer than spiral-fruited pondweed. Vasey's pondweed also produces floating leaves, which can be seen at the surface in shallow water. The occurrence of Vasey's pondweed within Catfish Lake is an indicator of a high-quality environment.

To determine if the 2008-2012 Eurasian water milfoil control project on Catfish Lake had any detectable impacts to the native aquatic plant community, and to determine if the control project was successful at reducing the Eurasian water milfoil population, Chi-square distribution analysis ($\alpha = 0.05$) was used to determine if there were any statistically valid changes in the occurrences of aquatic plant species from 2006 to 2012. Figure 8.2.4-3 displays the littoral occurrences of Eurasian water milfoil and native aquatic plant species that had a littoral occurrence of at least 5% in one of the two surveys. The figure divides the plants into dicots and non-dicots, as dicots are thought to be more susceptible to the 2,4-D herbicide treatments that were occurring in Catfish Lake.

As illustrated, the occurrence of Eurasian water milfoil in Catfish Lake was reduced by a statistically valid 91%, from an occurrence of 2.6% in 2006 to 0.2% in 2012. Three native aquatic plant species, northern water milfoil, small pondweed, and large-leaf pondweed exhibited statistically valid reductions in their occurrence from 2006 to 2012. Like Eurasian water milfoil, northern water milfoil is a dicot and is sensitive to the 2,4-D applications that have occurred on Catfish Lake. Unlike Eurasian water milfoil, small pondweed and large-leaf pondweed are monocots, and were historically not thought to be susceptible to dicot-selective herbicides like 2,4-D. However, emerging research conducted by the WDNR and US Army Corps of Engineers (USACE) is indicating that some of these species may be prone to decline following these types of treatments. It is possible that the declines observed in the small pondweed and large-leaf pondweed populations in Catfish Lake are a result of the Eurasian water milfoil spatially targeted spot-treatments that have been occurring since 2008. Four native aquatic plant species displayed statistically valid increases in their occurrence from 2006 to 2012, some of them very large gains like slender naiad and spiral-fruited pondweed. The occurrences of the remaining four native aquatic plant species, including one dicot (coontail), were not statistically different from 2006 to 2012.

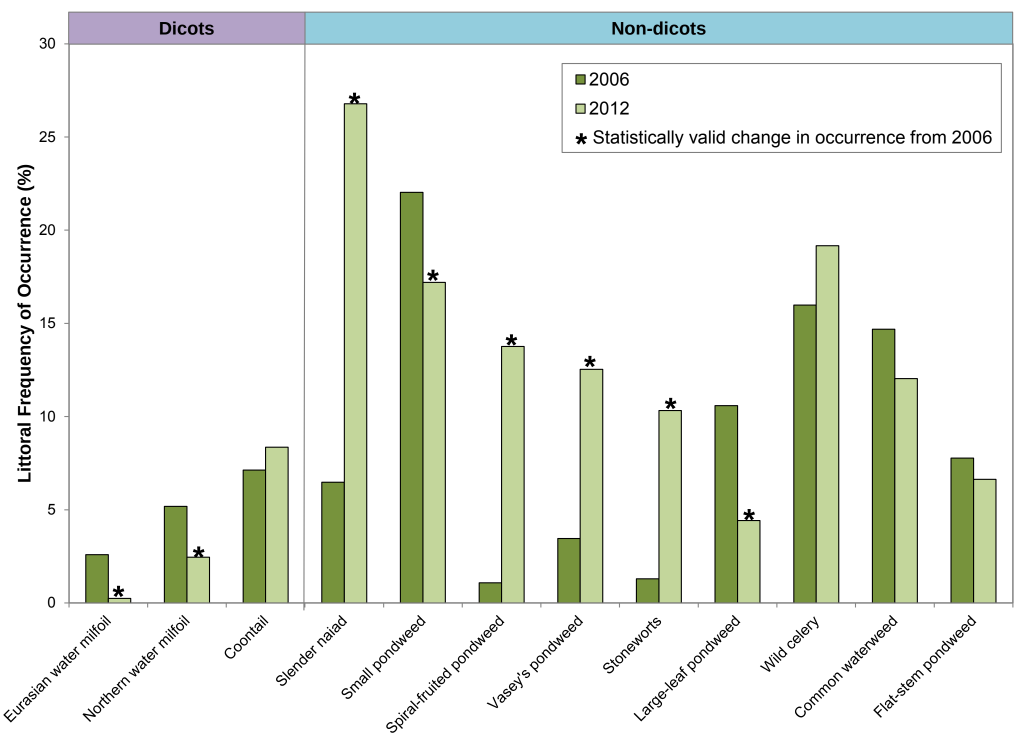

Figure 8.2.4-3. Catfish Lake littoral frequency of occurrence of select aquatic plant species from 2006 and 2012 point-intercept surveys. Please note that only those native species with an occurrence of at least 5% in one of the two surveys are displayed. Created using data from 2006 and 2012 point-intercept surveys.

As discussed in the primer section, the calculations used for the Floristic Quality Index (FQI) for a lake's aquatic plant community are based on the aquatic plant species that were encountered on the rake during the point-intercept survey and does not include incidental species. For example, while a total 30 native aquatic plant species were located in Catfish Lake during the 2012 survey, 28 were encountered on the rake and two were incidentally located. These 28 native species and their conservatism values were used to calculate the FQI of Catfish Lake's aquatic plant community in 2012 (equation shown below). The FQI was also calculated based on the species located during the 2006 survey.

$$\text{FQI} = \text{Average Coefficient of Conservatism} * \sqrt{\text{Number of Native Species}}$$

Figure 8.2.4-4 compares the FQI components of Catfish Lake from the 2006 and 2012 point-intercept surveys to median values of lakes within the Northern Lakes and Forests Lakes (NLFL) Ecoregion as well as the entire State of Wisconsin. In 2012, Catfish Lake's native species richness (28) is significantly higher than the median values for lakes within the ecoregion and the state. The average conservatism value in 2012 (6.6) is slightly lower than the ecoregional median but above the state median. Combining Catfish Lake's 2012 native species richness and average conservatism values yields an exceptionally high FQI value of 34.7, which greatly exceeds the ecoregional and state median values (Figure 8.2.4-4). The FQI values from 2012 are also higher than those calculated from point-intercept survey in 2006, indicating that the quality of Catfish Lake's aquatic plant community has not been degraded by the Eurasian water milfoil control project. This analysis indicates that Catfish Lake's aquatic plant community is of higher quality than the majority of lakes within the ecoregion and the entire state.

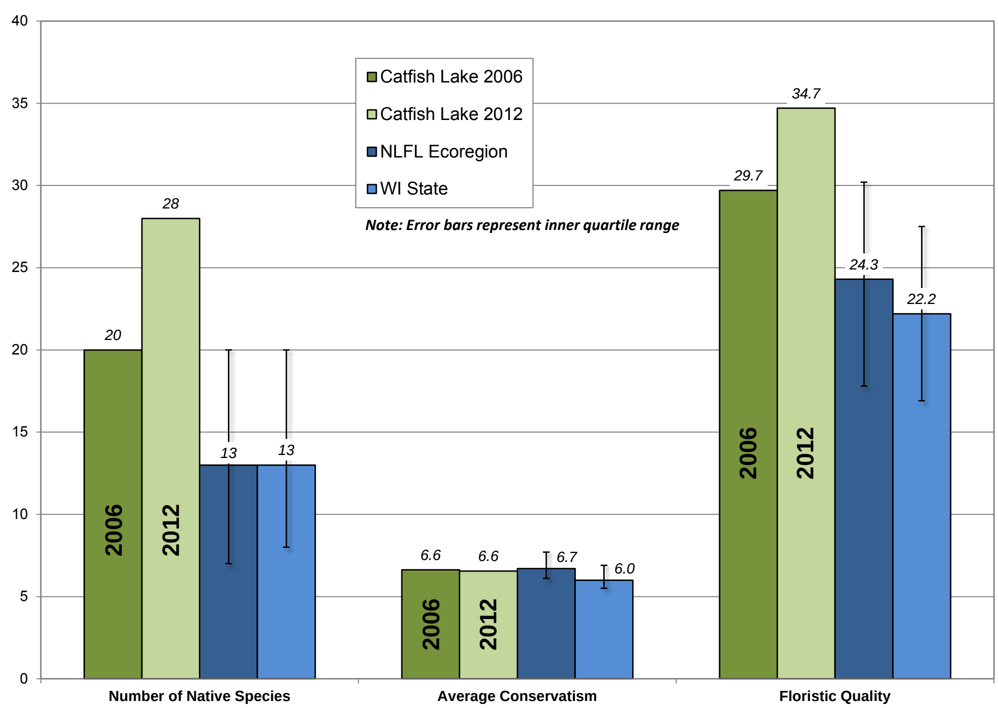

Figure 8.2.4-4. Catfish Lake Floristic Quality Index values. Created using data from 2006 and 2012 point-intercept surveys. Analysis follows Nichols (1999) where NLFL = Northern Lakes and Forests Lakes Ecoregion.

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As explained in the primer section, lakes with diverse aquatic plant communities have higher resilience to environmental disturbances and greater resistance to invasion by non-native plants. In addition, a plant community with a mosaic of species with differing morphological attributes provides zooplankton, macroinvertebrates, fish, and other wildlife with diverse structural habitat and various sources of food. Because Catfish Lake contains a high number of native aquatic plant species, one may assume the aquatic plant community also has high species diversity. However, species diversity is also influenced by how evenly the plant species are distributed within the community.

While a method for characterizing diversity values of fair, poor, etc. does not exist, lakes within the same ecoregion may be compared to provide an idea of how Catfish Lake's diversity value ranks. Using data obtained from WDNR Science Services, quartiles were calculated for 109 lakes within the NLF Ecoregion (Figure 8.2.4-5). Using the data collected form the 2012 point-intercept survey, Catfish Lake's aquatic plant community was shown to have exceptionally high species diversity with a Simpson's diversity value of 0.90, falling above the upper quartile value for lakes in both the ecoregion and the state. Catfish Lake's 2012 diversity was very similar to the diversity calculated from data collected during the 2006 point-intercept survey (0.89).

Figure 8.2.4-6 displays the relative frequency of occurrence of aquatic plant species in Catfish Lake from the 2012 point-intercept survey and illustrates relative abundance of species within the community to one another; the aquatic plant community is not overly dominated by a single or few species, which would create a less-diverse community.

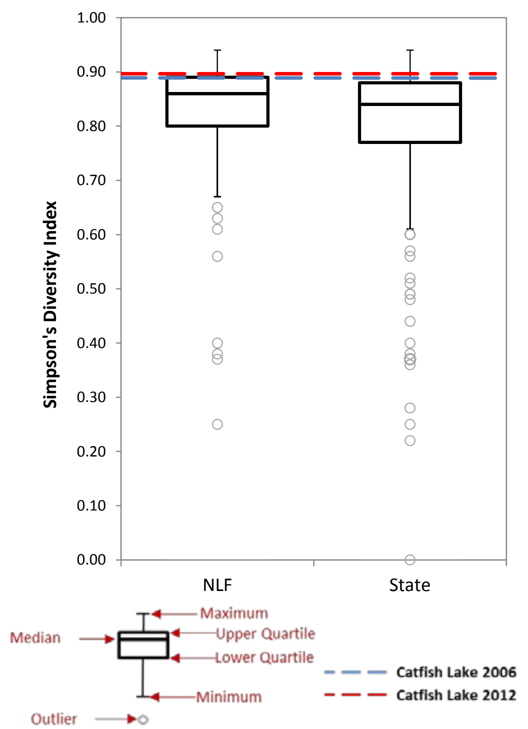


Figure 8.2.4-5. Catfish Lake species diversity index. Created using data from 2006 and 2012 point-intercept surveys. Ecoregion data provided by WDNR Science Services.

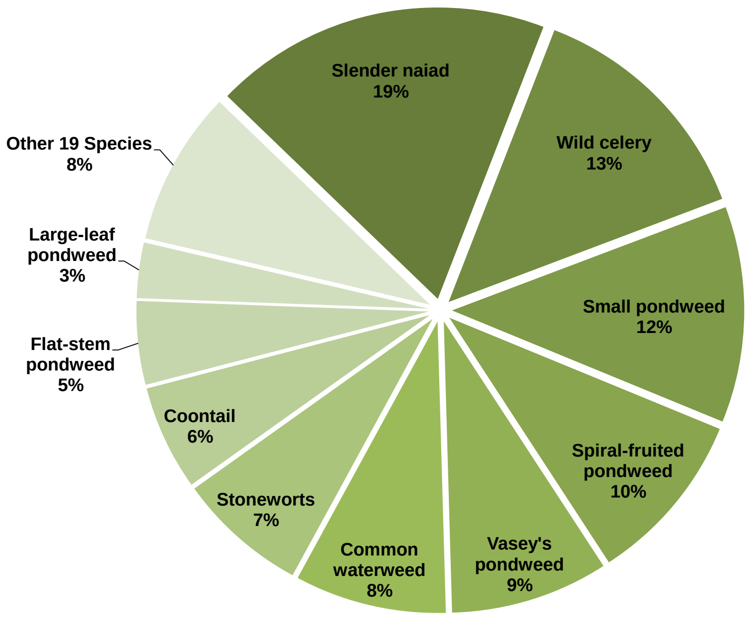


Figure 8.2.4-6. Catfish Lake 2012 aquatic plant relative frequency of occurrence. Created using data from 2012 aquatic plant point-intercept survey.

Overall, the 2012 point-intercept survey on Catfish Lake indicated that the Eurasian water milfoil control project may have had an adverse impact to populations of small pondweed and large-leaf pondweed, as indicated by statistically valid reductions in their occurrence from the 2006 to 2012 surveys. However, Catfish Lake still contains healthy populations of these two species, and four other native species saw large, statistically valid increases in their occurrence. In addition, average conservatism remained the same from 2006 to 2012, while native species richness, Floristic Quality, and species diversity increased, indicating there were no significant impacts to the overall quality of Catfish Lake's aquatic plant community.

The 2013 aquatic plant community mapping survey revealed that Catfish Lake contains approximately 27.0 acres of emergent and floating-leaf aquatic plant communities (Table 8.2.4-2, Catfish Lake – Map 4). Twenty-six emergent and floating-leaf aquatic plant species were located in the lake in 2012 (Table 8.2.4-1). These plant communities provide valuable fish and wildlife habitat important to the ecosystem of the lake. The community map represents a 'snapshot' of the important emergent and floating-leaf plant communities, and a replication of this survey in the future will provide a valuable understanding of the dynamics of these communities within Catfish Lake. This is important, because these communities are often negatively affected by recreational use and shoreland development.

Table 8.2.4-2. Acres of emergent and floating-leaf aquatic plant communities in Catfish Lake. Created using data from 2013 aquatic plant community mapping survey.

Plant Community	2013 Acres
Emergent	0.0
Floating-Leaf	7.5
Mixed Emergent & Floating-Leaf	19.5
Total	**27.0**

8.2.4 Catfish Lake Implementation Plan

The Implementation Plan below is a result of collaborative efforts between Catfish Lake stakeholders, ERCLA, and ecologists/planners from Onterra. This plan provides goals and actions created to protect the quality and integrity of Catfish Lake and will serve as reference for keeping stakeholders on track and focused upon these science-driven management activities.

While the lakes within the Lower Eagle River Chain of Lakes are relatively similar in terms of their water quality and aquatic plant communities, each lake possesses its own unique attributes. This uniqueness leads to the need to create individual plans aimed at managing the specific needs of each individual lake. Some of the lakes within the Lower Eagle River Chain (i.e. Scattering Rice Lake) have more complicated management needs than others, but in general most lakes' needs center on protecting the current quality of the lake and restoring/protecting immediate shoreland areas. The Chain-wide Implementation Plan will serve each of the project lakes well in terms of protecting their current condition as a chain. Catfish Lake's Implementation Plan illustrates how Catfish Lake stakeholders should proceed in implementing applicable portions of the Chain-wide Implementation Plan for their lake.

Chain-wide Implementation Plan – Specific to Catfish Lake

Chain-wide Management Goal 1: Maintain Current Water Quality Conditions

Management Action:	Continue water clarity monitoring in Catfish Lake through the WDNR Citizen Lake Monitoring Network (CLMN).
Timeframe:	Continuation of current effort
Facilitator:	Jeff Boville and John Lansing, current Catfish Lake CLMN volunteers
Description:	Monitoring water quality is an important aspect of every lake management planning activity. Collection of water quality data at regular intervals aids in the management of the lake by building a database that can be used for long-term trend analysis. Early discovery of negative trends will likely aid in an earlier definition of what may be causing the trend. The Citizens Lake Monitoring Network (CLMN) is a WDNR program in which volunteers are trained to collect water quality data on their lake. Volunteers trained as a part of the CLMN program begin by collecting Secchi disk transparency data annually. If funding is available, the lake group may enter into the *advanced program* and collect water chemistry data (chlorophyll-a and total phosphorus). The Secchi disk readings and water chemistry samples are collected three times during the summer and once during the spring. As a part of this program, these data are automatically added to the WDNR database and available through their Surface Water Integrated Monitoring System (SWIMS).

Volunteers from Catfish Lake have been collecting water quality data intermittently since 1992. Catfish Lake is not currently enrolled in the advanced water program and is currently collecting water clarity data. As is discussed within the Chain-Wide Implementation Plan, if additional funding should become available to include additional lakes within the chain in the advanced monitoring program, Scattering Rice Lake and Watersmeet have been given priority due to their positions within the chain. Catfish Lake currently has active volunteers (Jeff Boville and John Lansing) who collect and enter water quality data into the WDNR's SWIMS database on an annual basis. Catfish Lake (and ERCLA) recognizes the importance of continuing this effort which will supply them and resource managers with valuable data about their lake. Moving forward, it is the responsibility of Jeff Boville and John Lansing, the current CLMN volunteers, to notify Dave Mueller, the current chair of the ERCLA Lakes and Shores Committee and coordinator of the chain's CLMN volunteers, when a change in the collection volunteer occurs or is needed. Dave (or the current Lakes and Shores Committee chair) will contact Sandra Wickman (715.365.8951) or the appropriate WDNR/UW Extension staff to ensure the proper training occurs and the necessary sampling materials are received by the new volunteer.

Action Steps:

1. Jeff Boville and/or John Lansing, current CLMN volunteers, continue to collect water quality data and enter data into WDNR SWIMS database.
2. Jeff Boville and/or John Lansing, current CLMN volunteer, notify Dave Mueller or current Lakes and Shores Committee chair when a new Catfish Lake volunteer is needed.

Chain-wide Management Goal 2: Lessen the Impact of Shoreline Development on the Eagle River Chain of Lakes

Management Action: Investigate restoring highly developed shoreland areas on the Eagle River Chain of Lakes.

Description: As part of the planning project, the entire shoreline of Catfish Lake was categorized based on the amount of development present. The results of this survey revealed that approximately 41% (4.7 miles) of the shoreline are in an urbanized or developed-unnatural state, 36% (4.1 miles) is in a developed-semi-natural state, and 23% (2.6 miles) is in a developed-natural or natural/undeveloped state. Continuing research indicates that the shoreland zone is a critical component of a lake's ecology through providing both pollutant buffering and wildlife habitat. In addition, natural shoreland areas also increase the lake's aesthetic appeal.

ERCLA's Shores Subcommittee will be working with Quita Sheehan from the Vilas County Land and Water Department to gather information on initiating and conducting shoreland restoration projects. The Shores Subcommittee will serve as a contact point for property owners who are interested in pursuing shoreland restoration on their property. Interested property owners may contact ERCLA for more information on shoreland restoration plans, financial assistance, and benefits of implementation.

Management Action: Preserve natural shoreland areas on the Eagle River Chain of Lakes.

Description: While approximately 41% of Catfish Lake's shoreline is in a highly-developed state, approximately 23% of the shoreline contains little to no development. Preservation of these natural areas is very important for the lake's overall health, and owners of these properties should be educated on the benefits their shoreland is providing to Catfish Lake and to the entire chain.

The shoreland areas delineated as Natural and Developed-Natural should be prioritized for education initiatives and physical preservation. The ERCLA Shores Subcommittee will work with appropriate entities to research grant programs and other pertinent information that will aid ERCLA in preserving the Eagle River Chain's shoreland. This would be accomplished through education of property owners, or direct preservation of land through implementation of conservation easements or land trusts that the property owner would approve of. Catfish Lake stakeholders may assist in this management action by attending educational events held by ERCLA and by aiding in distributing ERCLA materials to Catfish Lake property owners.

Management Action: Investigate with WDNR and private landowners to expand coarse woody habitat in the Eagle River Chain of Lakes.

Description: During the Catfish Lake shoreland assessment, approximately 17 pieces of coarse woody habitat (CWH) per shoreline mile were observed. Often, property owners will remove downed trees, stumps, etc. from a shoreland area because these items may impede watercraft navigation shore-fishing or swimming. However, these naturally occurring woody pieces serve as crucial habitat for a variety of aquatic organisms, particularly fish, and also aid in reducing shoreline erosion.

The ERCLA Shores Subcommittee will encourage its membership to implement coarse woody habitat projects along their shoreland properties. Habitat design and location placement would be determined in accordance with the WDNR fisheries biologist. Catfish Lake stakeholders interested in implementing a coarse woody habitat project along their property or who have questions about the benefits of coarse woody habitat should contact ERCLA.

Chain-wide Management Goal 3: Actively Manage Existing and Reduce the Likelihood of Further Aquatic Invasive Species Establishment within the Eagle River Chain of Lakes

Management Action: Continue annual monitoring of aquatic invasive species on the Lower Eagle River Chain of Lakes.

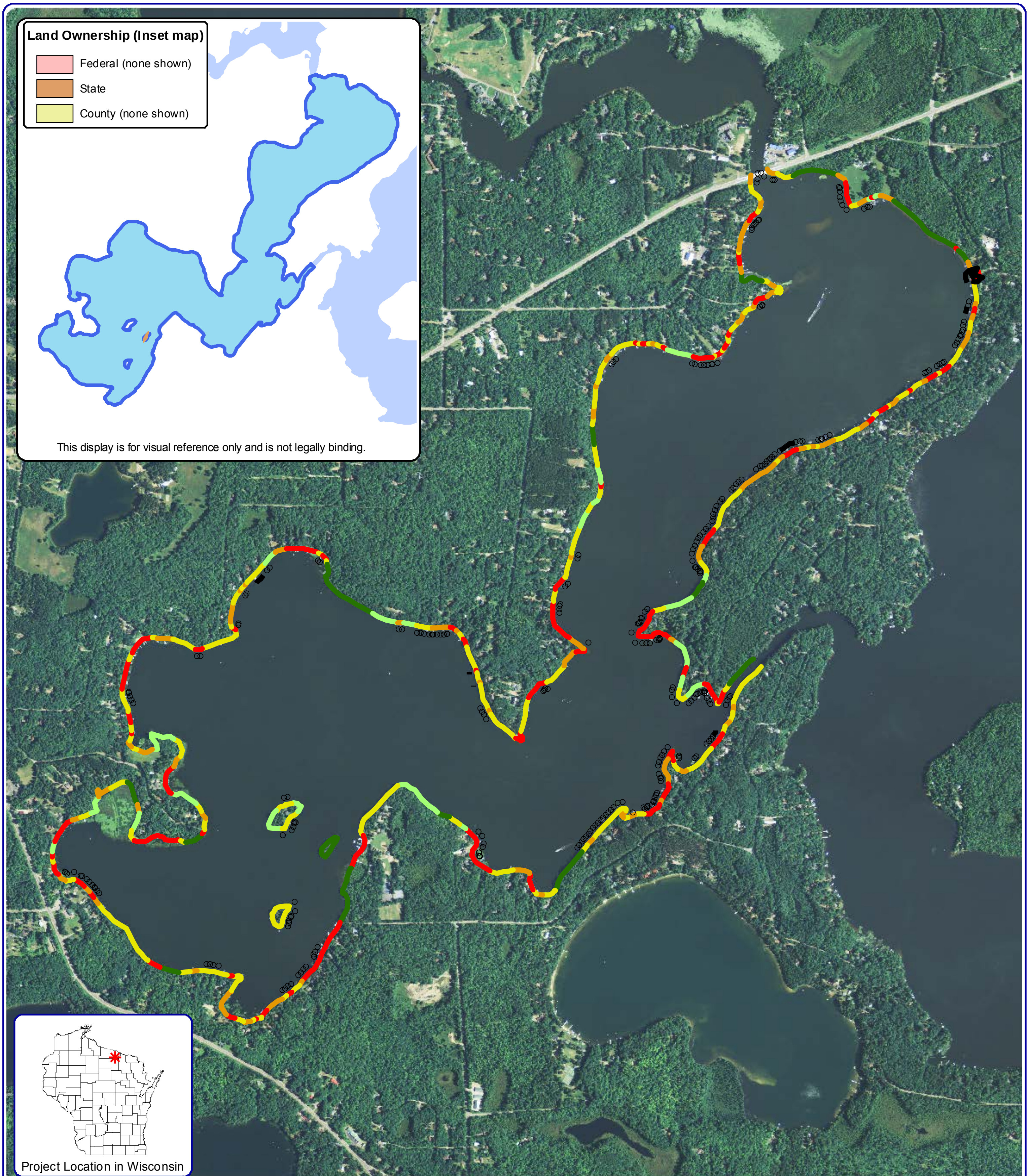
Description: Of the aquatic invasive species currently present in the Lower Eagle River Chain of Lakes, Eurasian water milfoil, purple loosestrife, pale-yellow iris, and garden yellow loosestrife are currently being actively managed. Catfish Lake stakeholders may participate in a variety of ways to aid in managing aquatic invasive species in Catfish Lake and throughout the chain. Those who are interested in participating in aquatic invasive species monitoring and management should contact ERCLA.

Catfish Lake stakeholders can keep themselves up to date on aquatic invasive species matters through attending WDNR training sessions, media releases, or participating in Catfish Lake Association and ERCLA meetings. Catfish Lake stakeholders can also participate in the active annual monitoring of Eurasian water milfoil, purple loosestrife, pale-yellow iris, and garden yellow loosestrife on Catfish Lake and/or volunteer to conduct watercraft inspections at designated boat landings in accordance with the Clean Boats Clean Waters Program. A dditionally, Catfish Lake stakeholders can also report sightings of aquatic invasive species to ERCLA and remove occurrences of purple loosestrife, pale-yellow iris, and/or garden yellow loosestrife on t heir property in accordance with methods determined by ERCLA and the Vilas County Invasive Species Coordinator.

Management Goal 4: Continue and Expand Awareness and Education of Lake Management and Stewardship Matters to Eagle River Chain of Lakes Riparians and the General Public

Management Action: ERCLA will continue to promote stakeholder involvement and inform stakeholders of various lake issues as well as the quality of life on the Eagle River Chain of Lakes.

Description: Catfish Lake stakeholders can assist in the implementation of this action by actively participating in ERCLA-associated educational initiatives. P articipation may include attending presentations and trainings of educational topics, volunteering at local and regional events, participating in ERCLA committees, or simply notifying ERCLA of concerns regarding Catfish Lake and its stakeholders.



1,750
Feet

Legend

Natural/Undeveloped
Developed-Natural
Developed-Semi-Natural
Developed-Unnatural
Urbanized

Seawall
Masonary/Wood/Metal
Rip-Rap

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815 Prosper Rd
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

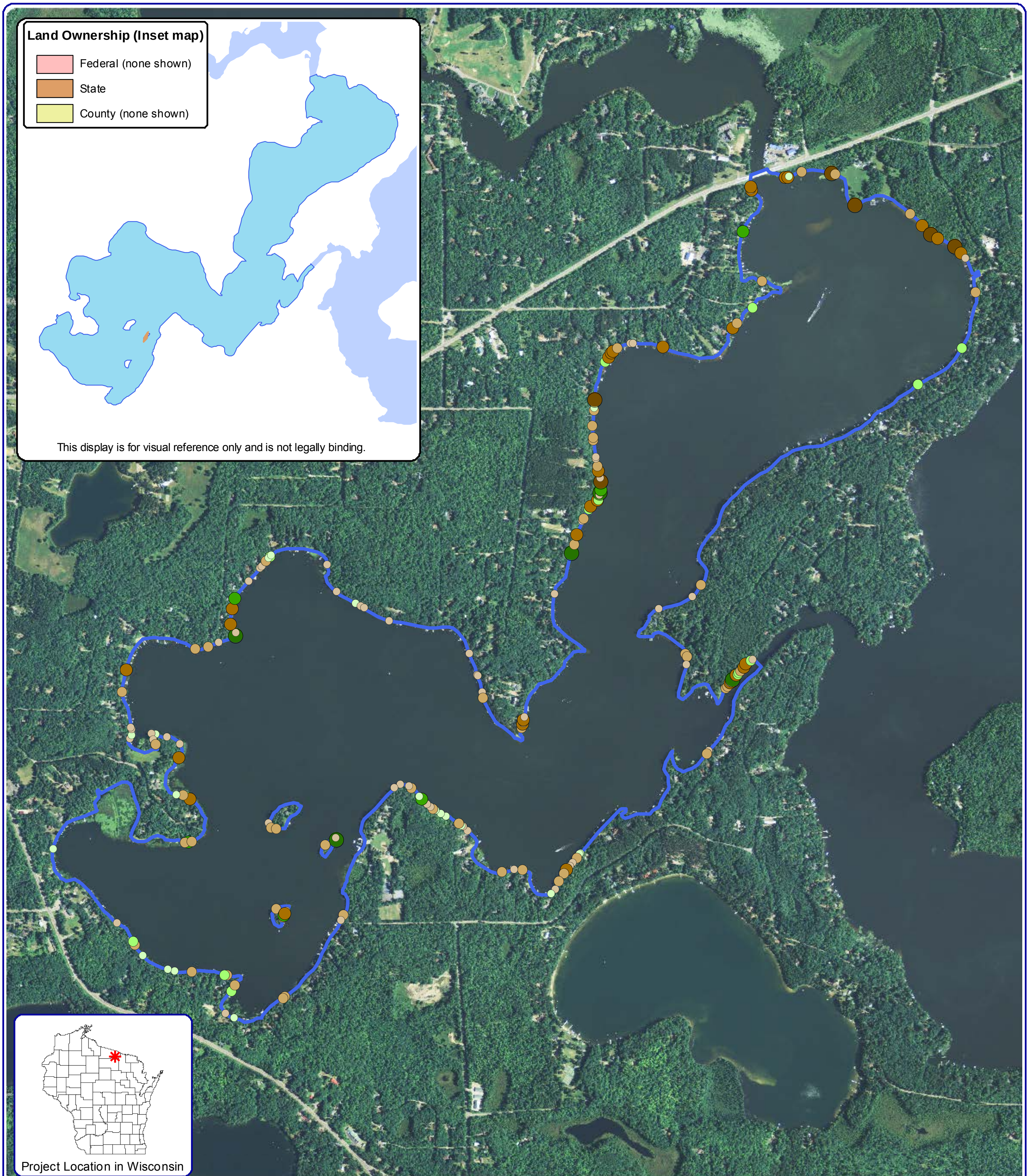
Sources:
Orthophotography: NAIP, 2010
SCA Survey: Onterra, 2013
Map date: December 2, 2013
Filename: Catfish_Map1_SCA_2013.mxd

Catfish Lake - Map 1

Lower Eagle River Chain of Lakes

Vilas & Oneida Counties, Wisconsin

2013 Shoreland Condition Assessment



N
W E
S

1,750

Feet

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920.338.8860
www.onterra-eco.com

Sources:
Orthophotography: NAIP, 2010
SCA Survey: Onterra, 2013
Map date: December 2, 2013
Filename: Catfish_Map2_CWH_2013.mxd

Legend

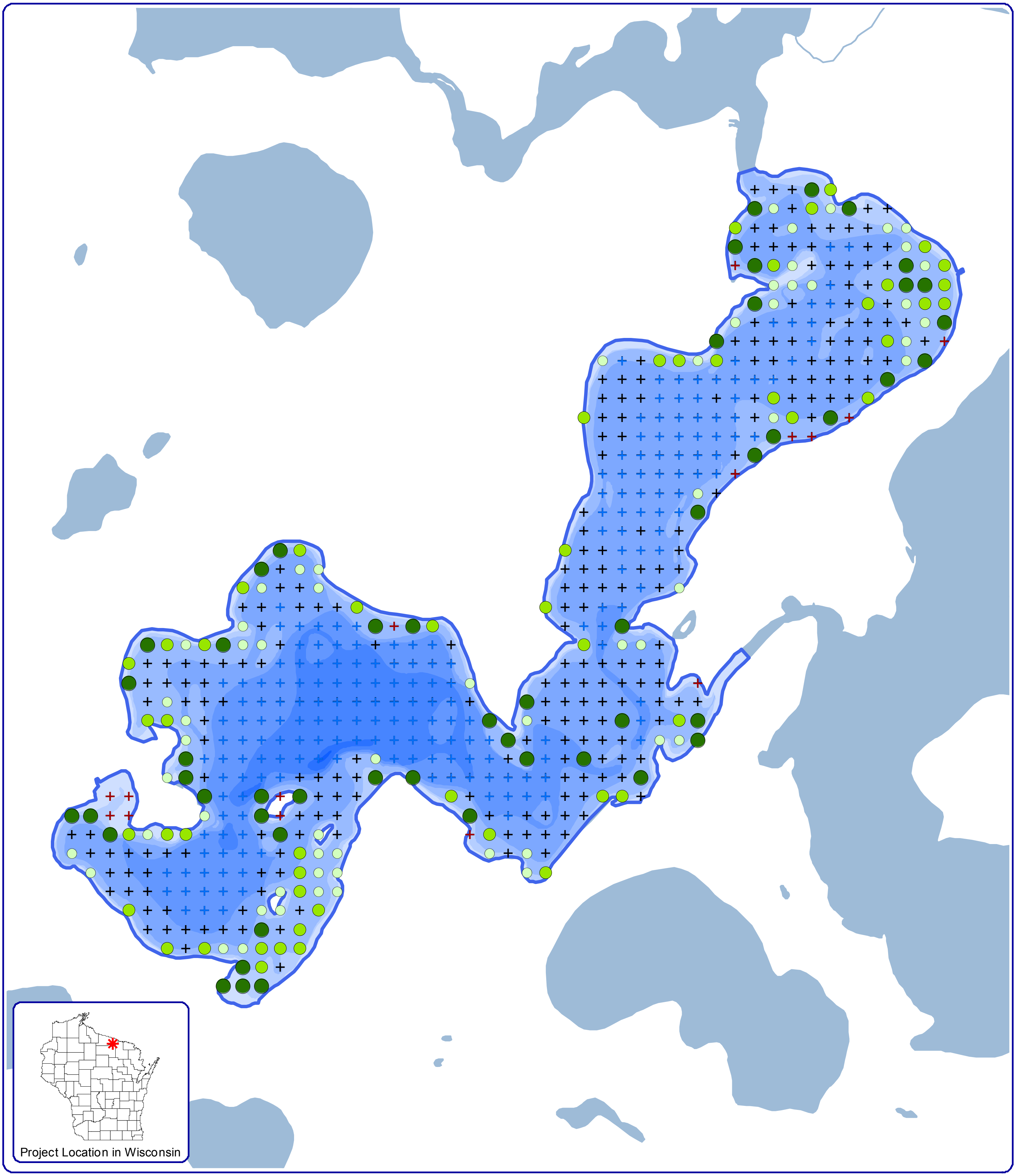
2-8 Inch Pieces	8+ Inch Pieces	Cluster of Pieces
No Branches	No Branches	No Branches
Minimal Branches	Minimal Branches	Minimal Branches
Moderate Branches	Moderate Branches	Moderate Branches
Full Canopy	Full Canopy	Full Canopy

Catfish Lake - Map 2

Lower Eagle River Chain of Lakes

Vilas & Oneida Counties, Wisconsin

2013 Course Woody Habitat



N S E W

1,800

Feet

Legend

- No Vegetation
- Total Rake Fullness = 1
- Total Rake Fullness = 2
- Total Rake Fullness = 3
- Deeper Than Max Depth of Plants
- Non-Navigable

Catfish Lake - Map 3

Lower Eagle River Chain of Lakes

Vilas & Oneida Counties, Wisconsin

2012 Aquatic Plant Distribution

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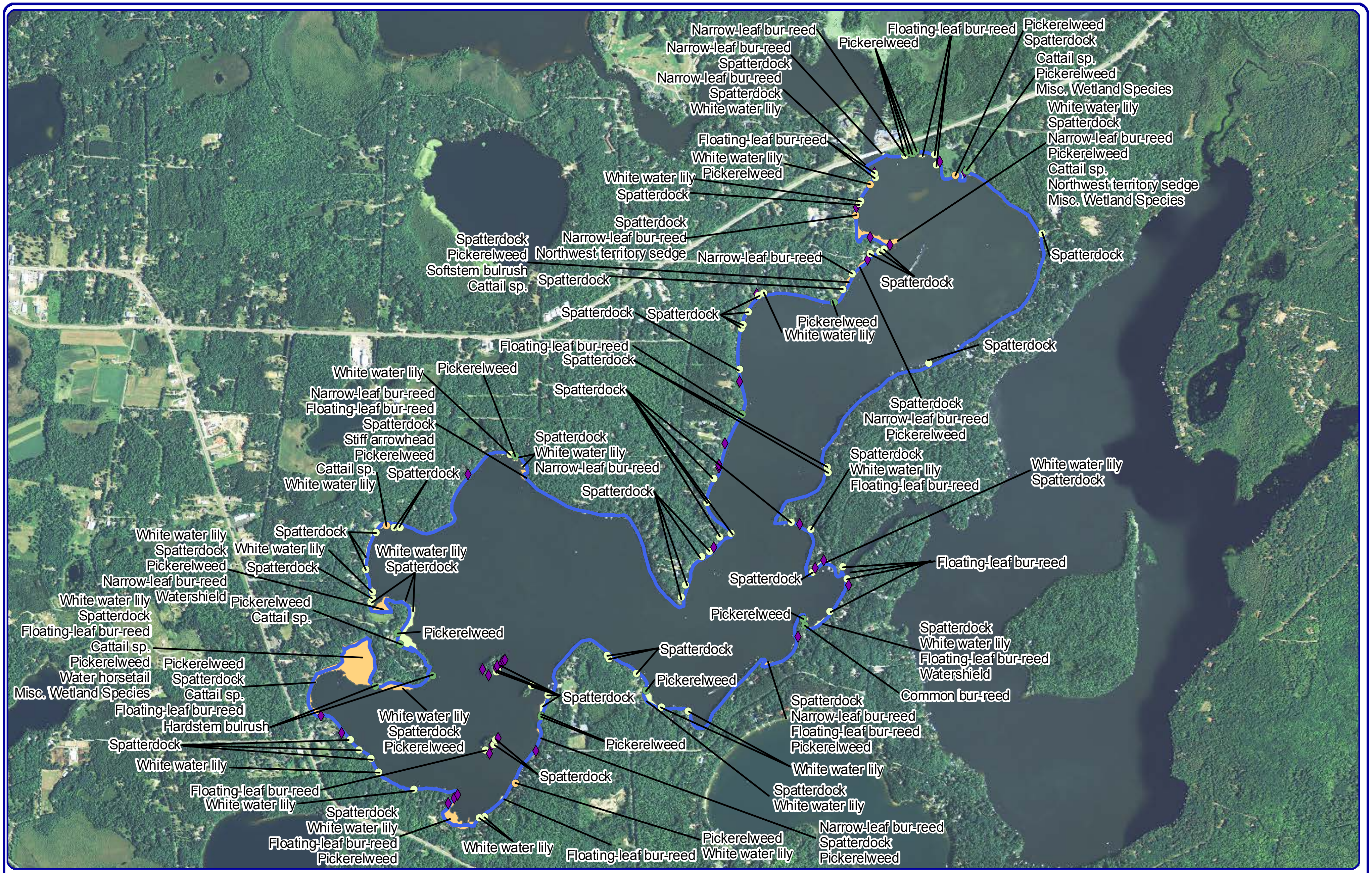
815 Prosper Rd
De Pere, WI 54115
920.338.8860
www.onterra-eco.com

Sources:
Orthophotography: NAIP, 2010
SCA Survey: Onterra, 2013
Map date: December 2, 2013
Filename: Catfish_Map3_TRFPI_2012.mxd



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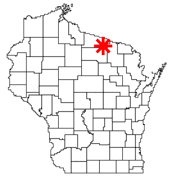
920.338.8860
www.onterra-eco.com

Sources:
Aquatic Plants: Onterra, 2013
Orthophotography: NAIP, 2010
Map date: November 7, 2013
Filename: Catfish_Map4_Comm_2013.mxd



Project Location in Wisconsin

Legend

Large Plant Community	Small Plant Community	Exotic Plant Community
Emergent	Emergent	Purple Loosestrife
Floating-Leaf	Floating-Leaf	
Mixed Emergent & Floating-Leaf	Mixed Emergent & Floating-Leaf	

Catfish Lake - Map 4

Lower Eagle River Chain of Lakes
Vilas & Oneida Counties, Wisconsin

Emergent & Floating-Leaf Aquatic Plant Communities